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# IN RE UNITED STATE PATENT APPLICATION

# FOR

# PLANAR INVERTED F ANTENNA AND METHOD OF MAKING THE SAME

# OF


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# PLANAR INVERTED F ANTENNA AND METHOD OF MAKING THE SAME

## FIELD OF THE INVENTION

The present invention relates to antennas and, more particularly, to planar inverted F antennas.

## BACKGROUND OF THE INVENTION

RF antennas are widely used to provide wireless capability in communication devices such as cellular telephones, wireless personal digital assistants (PDAs), portable computers, electronic games, and the like.

One common antenna is a planar inverted F antenna (the "PIFA"). The PIFA is a small antenna that can conveniently fit in most electronic devices. The PIFA includes a radiating patch, a carrier, and a ground plane. The radiating patch includes a ground connector and a feed connector. In a known PIFA, the ground and feed connectors extend from the periphery of the radiating patch for connection to the ground plane and power feed of a wireless communication device, respectively. Alternatively, an internal connection to the radiating patch has been provided by a separate spring finger attached to either the carrier molding or to a printed circuit board of the wireless communication device.

## SUMMARY OF THE INVENTION

A radiating patch of a PIFA having at least one connector formed from the radiating patch material and provides a cutout region within the periphery of the radiating patch. Further, a PIFA including such a radiation patch is provided also. The contact is formed by cutting material from a patch enabling the connector to be provided anywhere on the radiating patch instead of being limited to the periphery of the radiating patch.

The present invention also provides a method of making the radiating patches and the PIFAs. The method includes providing a conductive blank

having a periphery and cutting a first connector from a portion of the blank internal to the periphery. The first connector is bent away from the blank to form a cutout region in the blank. A second connector is formed on the conductive blank also.

The foregoing and other features, utilities and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention as illustrated in the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWING

The above and other objects and advantages of the present invention will be apparent upon consideration of the following detailed description, taken in conjunction with the accompanying drawings, in which like reference characters refer to like parts throughout, and in which:

Figure 1 depicts a perspective view of an antenna illustrative of the present invention assembled onto a printed circuit board;

Figure 2 depicts an exploded view of the antenna of Figure 1;

Figure 3 depicts a blank for forming a radiating patch of the antenna of Figure 1; and

Figure 4 depicts bottom view of the radiating patch of the antenna Figure 1.

## DETAILED DESCRIPTION

Figure 1 shows an assembled Planar Inverted F Antenna (PIFA) 4 illustrative of the present invention, which may be used in a wireless communication device such as a cellular telephone, a wireless personal digital assistant (PDA), a laptop computer, and the like. The PIFA 4 is connected to a printed circuit board (PCB) 1, which may be a component of the wireless communication device.

Figure 2 shows an exploded view of the PIFA 4 shown in Figure 1. The PIFA 4 includes a carrier 2 and a patch 3. The patch 3 is shaped to radiate RF energy at particular frequencies. The patch 3, for example, may

include one or more internal, shaped cutout 32. Cutout 32 quasi partitions patch 3 for multiband operation.

The patch further includes a ground connector 33 and a feed connector 34 for electrically connecting the PIFA with a printed circuit board 1 of a wireless communication device. The ground connector 33 and/or the feed connector 34 may be plated with a suitable conductive material, such as nickel or gold, or may be left un-plated where desired. Where a connector is formed from a corrosion-resistant material, such as a copper/nickel/zinc material, or where otherwise desired, the ground connector 33 and/or the feed connector 34 may be left un-plated.

One or both of the connectors may be formed by cutting through the patch 3. As shown in Figure 2, for example, the feed connector 33 is formed by cutting through the patch 3 and leaving an internal cutout 31. For the purposes of the present invention, the terms "cut" or "cutting" include any means of forming a connector from within the periphery of the patch 3 whether by stamping, cutting, etching, engraving, scoring, and the like **[any other examples here?]**. Alternatively, a connector may be formed by cutting through the patch 3, such that the cutout 31 extends to the periphery of the patch 3. The cutout 31, whether internal or extending to the periphery of the patch 3, influences the radiating of the PIFA 4 in the same manner as the cutout 32. Although the cutout 31 is shown as a straight line, the cutout may alternatively form any other shape desired to improve the RF performance of the PIFA 4. For example, the cutout 31 may alternatively include a circle, an arc, a zig-zag line, a meander line, or any other geometric or irregular shape as desired to alter the RF performance of the PIFA 4. Further, although the feed connector 34 shown in Figures 2 and 4 is shown substantially coextensive with the cutout 31, the feed connector 34 (or the ground connector 33) may also be a portion of a larger cutout area.

One of the connectors also may be formed by bending a portion extending from the periphery of the patch 3. As shown in Figures 2-4, for example, the ground connector 33 is formed by bending a portion of the patch 3 that extends beyond the periphery of the patch 3. In this manner, the

connectors may be formed at any position desired on the patch 3 of the PIFA 4.

The carrier 2 may be formed of any suitable non-conducting material such as a dielectric **[or insulator?]** material (e.g., plastic molding). The carrier 2 supports the patch 3 and maintains the patch 3 in the location relative to the PCB of a wireless communication device. The carrier may be attached to the PCB by any means known in the art, such as by clipping, fixing with screws, and the like.

Pins 20 and/or locating blocks 22 may be used to align patch 3 on carrier 2. The locating pins 20 align with holes 30 (or depressions) in the patch 3. The locating blocks 22 align with cutout 32 and/or cutout 31. The pins 20 and/or blocks 22 may be deformed, such as by heat staking, to hold the patch 3 in place on the carrier 2. Alternatively, the patch 3 can be attached to the carrier by any other means known in the art, such as adhesive, double-sided adhesive tape, clipping, soldering, and the like.

The carrier 2 may further include an opening 21 to allow the feed connector 34 to make contact with a feed contact 11, such as a feed pad or other contactor. Another opening 23 (or notch) further allows the ground connector 33 to make contact with a ground contact 10, such as a ground pad or other ground connector.

Figure 3 shows a blank 5 that may be used to form the patch 3 shown in Figure 2. The blank 5 may be formed by a thin metal or electrically conductive plate such as a plate coated with an electrically conductive metal. The blank may alternatively be formed, for example, by a molded or cast plastic sheet coated with an electrically conductive material or formed by mixing an electrically conductive substance in a plastic raw material.

Figure 4 shows the underside of the patch 3 with the ground connector 33 and the feed connector 34 formed. The shape of the connectors 33 and/or 34 is preferably configured to ensure that adequate pressure is maintained between the connectors 33 and/or 34 and the respective ground contact 10 and feed contact 11 of a wireless communication device. The connectors 33 and/or 34 may also include dimples 35 and 36 to improve the reliability of the

connection between the connectors 33 and 34 of the PIFA and the contacts 10 and 11 of a wireless communication device. The shape of the connectors 33 and 34 may also be configured to aid in the location and fixing of the patch 3 to the carrier 2. While not necessary, connectors 33 and 34 should be formed from a material having some elasticity to facilitate the connectors.

While the invention has been particularly shown and described with reference to one or more embodiments herein, it will be understood by those skilled in the art that various other changes in the form and details may be made without departing from the spirit and scope of the invention.